Assessing Wisconsin's Forests from Various Points of View

Northern Mixed Forest

Ecological Capability

Glacial activity dramatically influenced the ecology of much of Wisconsin, and the entire Northern Mixed Forest region. The most recent glaciers receded from northern Wisconsin about 10,000 years ago, leaving glacial deposits covering much of the northeastern three fifths of the state.

Much of the surface hydrology of the Northern Mixed Forest results from glacial activity. Northern Wisconsin has one of the highest concentrations of freshwater lakes in the world. The Ojibwe word "wisconsin" actually means "gathering place of waters."

Most of the northern area of Wisconsin is a gently rolling plain, punctuated by steeper glacial features and a few ancient pre-glacial escarpments. Tim's Hill and Rib Mountain, the highest points in the state, occur in the northern region.

Most of the soils of the north developed from glacial till and loess (wind deposited material). They developed under forest vegetation, and tend to be lighter colored than soils further south. Most are loams or silts, fairly fertile, and supported complex, well-developed maple-hemlock forests.

Jim Escalante

The Northern Mixed Forest is composed of both conifer and broadleaf trees, and helps to protect the abundant water and soil resources of northern Wisconsin. Copper Falls State Park.

Figure 6

Map of Wisconsin's Northern Forest (below, left)

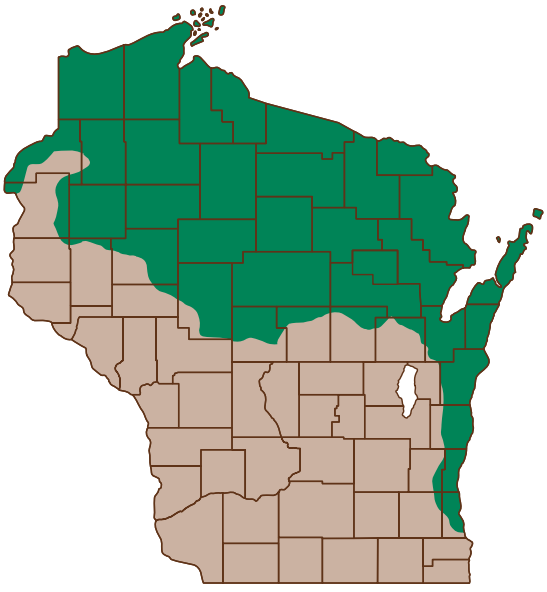
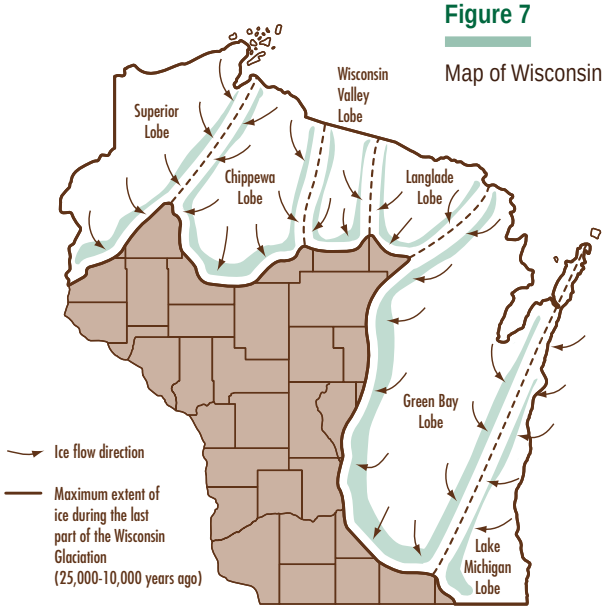


Figure 7

Map of Wisconsin glaciation (below, right)



Dorothy Ferguson

Over half of the northern region of Wisconsin is currently forested. This is a typical young pine forest in northern Wisconsin.

Areas of sandy, infertile, and droughty soils originated as glacial outwash. They supported pine barrens, pine forests, and some broadleaf forests (primarily oak, aspen, and white birch). These soils developed in the extreme northwest area of the state, as well as a limited area in northcentral Wisconsin, a small area in northeast Wisconsin, and a larger area extending into central Wisconsin. These areas tend to be more susceptible to fire as there is less moisture contained in both the soil and vegetation. The pine and hardwood species that grow in these areas are adapted to these unique conditions, namely droughty conditions and fire.

Along Lakes Michigan and Superior, clay soils developed. These areas tend to be fertile and moist due to the lakes' influence, and support a variety of forest vegetation.

The northern area of Wisconsin is well known for it's snowfall and extreme cold. Some areas receive well over 100 inches of snow per winter. This snow serves as both a moisture source and insulation for the soil and plants it covers. Total precipitation in the north ranges from 26 to 36 inches per year. Rain is generally consistent through the growing season, without any pronounced dry periods. This reliable moisture encourages complex forests, supporting many genera and species of both plants and animals.

Average annual temperatures in the Northern Mixed Forest region range from about 37 degrees to 45 degrees Fahrenheit. The usual high average daily temperatures in August are in the low 80s, and common low average daily temperatures in January are near zero. The average high daily temperature varies on a southwest to northeast gradient throughout the state, the southwest being significantly warmer. Growing degree days follow the same trend.

Climate, landform, soil and vegetation interact to result in a wide variety of site conditions in northern Wisconsin. This ecological capability influences what forest types and communities can develop across the landscape.

Current Status of Wisconsin's Northern Mixed Forest

Fewer people live in northern than southern Wisconsin. Consequently, because there is less pressure for urban development and a climate less suitable for agriculture, much of the north remains forested. Over 70% of Wisconsin's forests occur in the north, on only a little over 50% of the total land area. Over half of the Northern Mixed Forest region is forested.

Wisconsin's Northern Mixed Forest is owned by a wide array of individuals and organizations. Although there is significant public ownership in the

Figure 8

Map of Wisconsin's growing degree days. (A growing degree day is an index that combines factors of moisture and temperature to express vegetation growth.) (below, left)

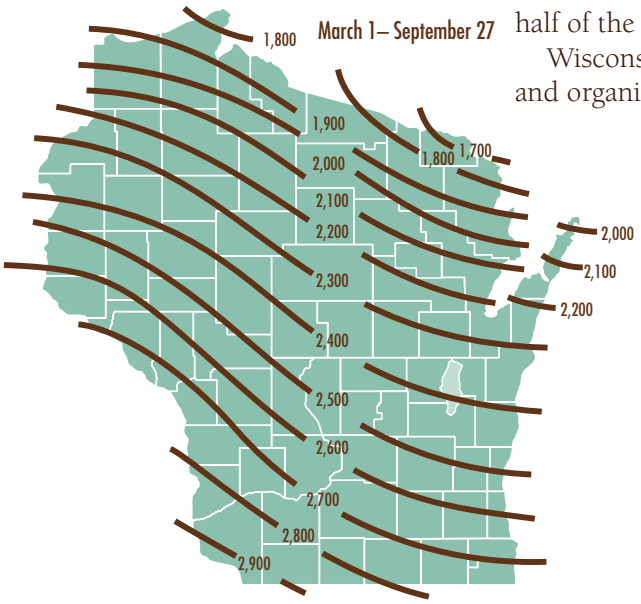
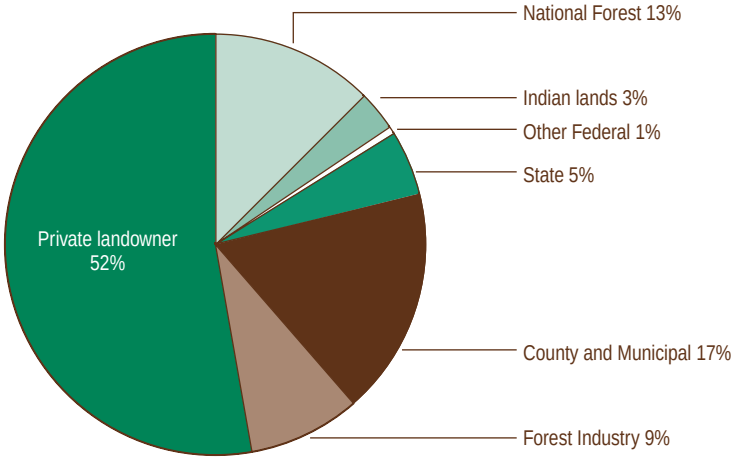


Figure 9

Northern mixed forest ownership, 1996 (below, right)



Robert Queen

Snow is abundant in northern Wisconsin. Snow serves both as a source of moisture and insulation against the bitter cold temperatures common in northern Wisconsin.

northern forests, the most common ownership class is non-industrial private owners. County and municipal ownership is also important in the Northern Mixed Forest. Many of these forests were once bankrupt farms that returned to county ownership after the Cutover. Third largest, in terms of acreage, is national forest land. The Chequamegon-Nicolet National Forest is composed of a number of large tracts located across Wisconsin's northern regions. Forest industry owns 9% of the northern forest, providing wood primarily for the paper industry. Wisconsin is the number one papermaking state in the nation. The State of Wisconsin owns about 5% of the northern forestland—mostly in the state forest system. Indian lands account for about 3% of the total forestland in the north.

The presence of both conifer and broadleaf species characterizes the Northern Mixed Forest. About 30 fairly common, native tree species can be found in the region. However, there are usually only a few primary species in any given locale. These primary species determine the *forest type* of an area.

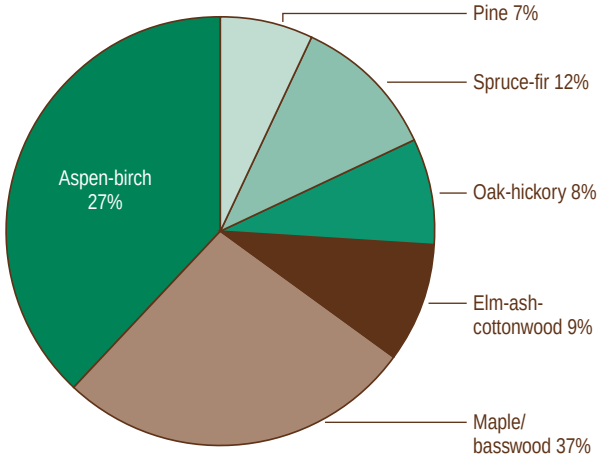


Figure 10

Northern forest types, by acreage, 1996

Common wildlife in Wisconsin's Northern Mixed Forest

Mammals

- white-tailed deer
- beaver
- black bear
- snowshoe hare
- raccoon
- red squirrel
- chipmunk
- other small rodents

Birds

- broad-winged and sharp-shinned hawks
- barred and saw-whet owls
- downy and pileated woodpeckers
- veery
- least flycatcher
- chickadee
- chestnut-sided warbler
- blue jay
- red-eyed vireo
- hermit thrush

Reptiles/amphibians (herptiles)

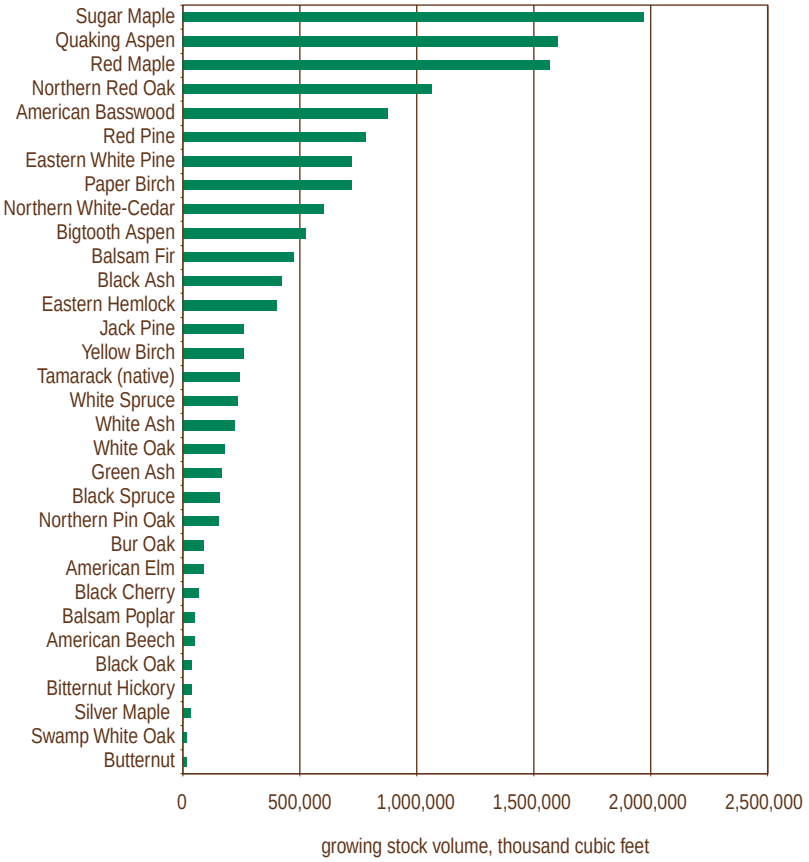
- American toad
- eastern garter snake
- leopard frog

Robert Queen

State land accounts for only about 5% of forestland in northern Wisconsin.

Figure 11

Northern Wisconsin growing stock volume by species, 1996



Common plants in maple-basswood forests

Woody shrubs

- beaked hazelnut *(Corylus cornuta)*
- leatherwood *(Dirca palustris)*
- elderberry *(Sambucus pubens)*
- alternate-leaf dogwood *(Cornus alternifolia)*
- bush-honeysuckle *(Diervilla lonicera)*
- raspberries *(Rubus* spp.)

Non-woody plants

- springbeauty *(Claytonia caroliniana)*
- large-flowered trillium *(Trillium grandiflorum)*
- wood anemone *(Anemone cinquefolia)*
- marsh blue violet *(Viola cucullata)*
- downy yellow violat *(V. pubescens)*
- Solomon's seal *(Polygonatum pubescens)*
- false Solomon's seal *(Smilacina stellata)*
- sweet cicely *(Osmorhiza* spp.)
- Jack-in-the-pulpit *(Arisaema atrorubens)*
- clubmosses *(Lycopodium* spp.)
- largeleaf aster *(Aster macrophyllus)*
- Canada mayflower *(Mianthemum canadensis)*

Maple-basswood forest type

The maple-basswood forest type is the most common forest type in the northern forest region, as well as the entire state. Over 4.2 million acres of the Northern Mixed Forest are maple-basswood forest type. A predominance of sugar maple and basswood characterize this type. Quaking aspen, paper birch, red maple, northern red oak, hemlock, yellow birch, and white pine are also common. Maple-basswood supports a variety of understory plants and animals.

The most important species, by volume, in the maple-basswood forest type are sugar maple, red maple, basswood, quaking aspen, northern red oak, and hemlock. Sugar maple, basswood, eastern hemlock, and yellow birch will be discussed in this section. Red maple will be discussed in the elm-ash-soft maple forest type discussion; quaking aspen will be discussed under the aspen-birch forest type, and northern red oak under the oak-hickory forest type.

Sugar Maple: Maple-basswood is the most common forest type in the northern region of Wisconsin (as well as statewide), and sugar maple *(Acer saccharum)* ranks first in volume in the northern forests. As succession proceeds, sugar maple probably will become even more common. In older forests sugar maple usually has a competitive advantage over other species due to its ability to regenerate and compete in shaded conditions [Curtis, 1959].

Between 1983 and 1996, sugar maple volume in the north increased by almost 62 million cubic feet. In 1996, there were about 1.97 billion cubic feet of sugar maple growing stock north of the tension zone.

Table 1: Forest types of Northern Wisconsin

Forest Type	% of Northern Forest	Characteristic tree species
Maple-basswood	38%	sugar maple *(Acer saccharum)* red maple *(Acer rubrum)* American basswood *(Tilia americana)* eastern hemlock *(Tsuga canadensis)* yellow birch *(Betula allegheniensis)* northern red oak *(Quercus rubra)* quaking aspen *(Populus tremuloides)* white ash *(Fraxinus americana)*
Aspen-birch	27%	quaking aspen *(Pupulus tremuloides)* bigtooth aspen *(Populus grandidentata)* paper birch *(Betula papyrifera)* red maple *(Acer rubrum)* balsam fir *(Abies balsamae)*
Elm-ash-soft maple	9%	red maple *(Acer sacchurum)* black ash *(Fraxinus nigra)* white ash *(Fraxinus americana)* American elm *(Ulmus americana)*
Oak-hickory	8%	northern red oak *(Quercus rubra)* northern pin oak *(Quercus ellipsoidalis)* white oak *(Quercus alba)* red maple *(Acer rubrum)* bigtooth aspen *(Populus tremuloides)* eastern white pine *(Pinus strobus)*
Spruce-fir	11%	white spruce *(Picea glauca)* black spruce *(Picea mariana)* balsam fir *(Abies balsamae)* northern white cedar *(Thuja occidentalis)* tamarack *(Larix laricina)* quaking aspen *(Populus tremuloides)*
Pine	7%	eastern white pine *(Pinus strobus)* red pine *(Pinus resinosa)* jack pine *(Pinus banksiana)*
Other northern species		mountain ash balsam poplar

Sugar maple follows quaking and bigtooth aspen as the most common species harvested in the northern region of Wisconsin. Between 1983 and 1996, an annual average of 21.1 million cubic feet of sugar maple were harvested from Wisconsin's northern forests. However, during the same period, sugar maple net average annual growth was 55.5 million cubic feet. In other words, over 60% of sugar maple growth was retained, adding to the net growth of the forest.

DNR Photo Archives

Since the last assessment, sugar maple volume increased 62 million cubic feet.

Sanborn

Maple-basswood forests, like this one in Rusk County, are the most common forest type in Wisconsin.

Robert Queen

Sugar maple provides many benefits, not least of which is the delicious maple syrup northern Wisconsin is famous for. This photo shows people tapping maple trees in late winter.

Basswood: American basswood (*Tilia americana*) is another primary species in the maple-basswood forests of northern Wisconsin. In 1996, there were 874.5 million cubic feet of basswood growing stock in Wisconsin's northern forests. This was a 28% increase over the 683.7 million cubic feet in the northern forests in 1983.

Like sugar maple, basswood volume is increasing as the forests mature. A fast growing tree, basswood is a common lumber species. Other important uses of basswood include hand carving, local crafts like basketry and rope making, and as a honey tree. Bees find the basswood's fragrant flowers very attractive as a nectar source [USDA Forest Service, 1990].

Basswood is harvested extensively in the north. An annual average of 10.6 million cubic feet of basswood was harvested in northern Wisconsin between 1983 and 1996. This was about two-thirds of the 15.9 million cubic feet of average net annual growth between 1983 and 1996. This resulted in 5.3 million cubic feet of basswood growth in northern Wisconsin.

An important pest for basswood is the basswood thrips. Rabbits may also feed on seedlings. Basswood is also very susceptible to fire [USFS, 1990].

Eastern Hemlock: Eastern hemlock *(Tsuga canadensis)* was historically a very important component of what is now the maple-basswood forest. At one time, hemlock was one of the two dominant species in the northern forests. With sugar maple, it composed a significant portion of forest vegetation before the Cutover, especially on wet-mesic and mesic sites.

Today hemlock is much less prevalent. For the most part, this is due to the Cutover beginning at the turn of the century. During the Cutover, Wisconsin's hemlock was cut for the tanning industry. The tannins in hemlock bark were used for tanning leather.

Robert Queen

Although hemlock was mostly removed from the northern forests during the Cutover, small patches are found throughout the range of hemlock in northern Wisconsin.

Hemlock is a long-lived, shade-tolerant, slow-growing tree. Individual trees can live up to 500 years, and may not bear seeds until they are 150 years old [USFS, 1990]. Harvest during the Cutover removed the mature trees that provide the seed source for future trees. Because of the scarcity of hemlock, recovery time for hemlock may take much longer than for other species like maple or pine. After the Cutover, few areas had sufficient hemlock composition to offer enough seed source to adequately regenerate hemlock.

For a long time, ecologists were concerned that hemlock would never make a comeback in Wisconsin's forests. However, new inventory data indicates that

DNR Photo Archives

Red-eyed vireos are common woodland birds in northern Wisconsin.

Figure 12

Hemlock size classes

Robert Queen

Trillium are common on the forest floor throughout Wisconsin. Their large, three-petaled flowers are easily identified in spring.

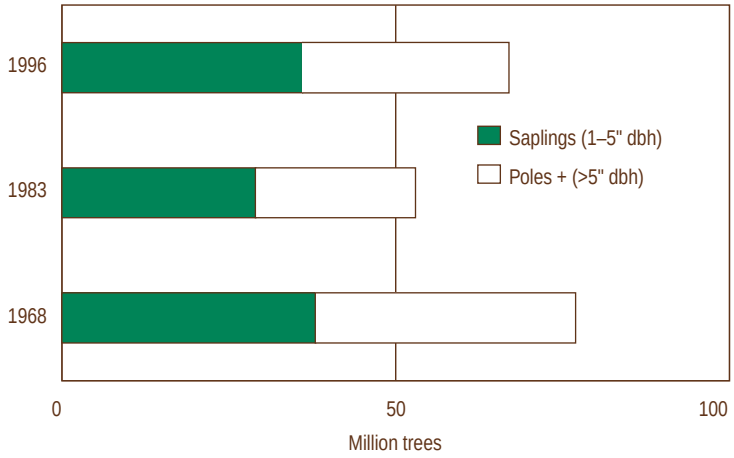
Common plants on aspen-birch forests

Woody plants

- beaked hazelnut *(Corylus cornuta)*
- American hazelnut *(C. americana)*
- mountain maple *(Acer spicatum)*
- speckled alder *(Alnus rugosa)*
- dwarf bush-honeysuckle *(Diervilla lonicera)*
- raspberries *(Rubus* spp.)
- gooseberry *(Ribes* spp.)
- willow *(Salix* spp.)
- sweetfern *(Comptonia perigrina)*

Non-woody plants

- largeleaf aster *(Aster macrophylla)*
- wild sarsaparilla *(Aralia nudicaulis)*
- Canada mayflower *(Mianthemum canadensis)*
- bunchberry *(Cornus canadensis)*
- yellow bead lily *(Clintonie borealis)*
- roughleaf ricegrass *(Oryzopsis asperifolia)*
- sweet-scented bedstraw *(Galium triflorum)*
- lady fern *(Athyrium felix-feminina)*
- bracken fern *(Pteridium aquilinum)*
- sedges *(Carex* spp.)
- goldenrods *(Solidago* spp.)



hemlock may be recovering in Wisconsin's northern forests. In 1983, there were about 284 million cubic feet of growing stock in the northern forests. In 1996, that figure had increased to 401 million cubic feet. The majority of this growth is on existing large hemlock. Currently, only about half of hemlock's growth is being harvested.

Despite browsing by the large Wisconsin deer population, numbers of hemlock trees also increased between 1983 and 1996, including 1–3 inch diameter trees [Schmidt, 1997].

Yellow Birch: Yellow birch *(Betula alleghaniensis)* is a relatively common species in maple-basswood forests. Like its associate, eastern hemlock, yellow birch is a long-lived, shade-tolerant, slow-growing species [USDA Forest Service, 1990]. Over the last inventory period, from 1983 to 1996, yellow birch volume has increased a little over 4%, from 233.4 million cubic feet to 260.6 million cubic feet. Between 1983 and 1996, an annual average of 2.3 times as much yellow birch timber was harvested—about 3.2 million cubic feet—than grew—about 1.5 million cubic feet. Sources of natural yellow birch mortality are the birch leaf miner, bronze birch borer, injury, and windthrow.

Aspen-Birch Forest Type

Second to maple-basswood in total area is the aspen-birch forest type. Just less than 3.1 million acres of the Northern Mixed Forest region are aspen-birch. Important tree species in this forest type include quaking aspen, bigtooth aspen, and paper birch. Wildlife in aspen-birch forest type is abundant—many of the state's most important game animals favor this type of forest. The most important species, by volume, in the aspen-birch forest type are quaking aspen, paper birch, and bigtooth aspen.

Quaking aspen removals are the highest of any species in the state. It is very important in the Wisconsin pulp and paper industries, which produce 11% of the United States' paper supply [Wisconsin Paper Council, 1999].

DNR Photo Archives

The American toad is found in all of Wisconsin's forest types.

Aspen: There are two species of aspen in Wisconsin—quaking and bigtooth. Quaking aspen *(Populus tremuloides)*, distinguished from bigtooth *(Populus grandidentata)* by its smaller-toothed leaf margins, has a range that stretches all the way across North America, and probably is the most widely distributed tree on the continent [USDA Forest Service, 1990]. Bigtooth aspen is also quite common in northern Wisconsin.

In 1996, there were 1.6 billion cubic feet of quaking aspen growing stock in northern Wisconsin. This figure had decreased from just less than 1.7 billion cubic feet in 1983. Bigtooth growing stock volume also decreased slightly between 1983 and 1996, from 526 million cubic feet to 522 million cubic feet. This decrease in growing stock is due to the predictable aging of the northern forests, which are succeeding from early successional species like aspen to more shade-tolerant species like sugar maple and basswood.

Between 1983 and 1996, more aspen was harvested and died from natural causes than grew in Wisconsin's northern forests. Quaking aspen average net annual growth between 1983 and 1996 was 50 million cubic feet; removals were 52 million cubic feet. Bigtooth aspen average net annual growth was 15 million cubic feet; removals were 23 million cubic feet. As has been the trend for many years, quaking aspen and bigtooth aspen were the most harvested species between 1983 and 1996.

Aspen are short-lived, prolific species. Aspen regenerates well after severe disturbances, either by sprouting after clearcutting or seeding after fire, which open up the forest canopy and allow sufficient light to penetrate for these sun-loving species. They are susceptible to many diseases and other mortality factors. In Wisconsin, aspen is used for fiberboard, pulpwood, flakeboard, and some sawtimber.

Many kinds of wildlife feed on aspen, sometimes damaging individual trees, or, in the case of beavers, entire stands. Deer, snowshoe hare, sapsuckers, porcupines, and beaver are some of the primary animals impacting aspen [USFS, 1990].

Staber W. Reese

Almost 3.1 million acres of the northern forest is aspen-birch forest type. Vilas County.

DNR Photo Archives

Bunchberry is a common flowering plant in aspen-birch forests. In the fall, the plant produces bright red edible berries.

Robert Queen

Paper birch is quite distinctive, easily identified by it's characteristic papery, peeling white bark.

Robert Queen

Black spruce swamps are fairly common in the northern forests of Wisconsin. They are a good example of spruce-fir forests. Northern Highland American Legion State Forest.

Allen Haukom

Balsam fir is declining throughout northern Wisconsin. This open-grown balsam fir was photographed in Price County.

Paper Birch: The beautiful paper birch *(Betula papyrifera)*, sometimes called white birch, is perhaps the most identifiable tree in Wisconsin's northern forests. Its distinctive papery bark distinguishes it from all other hardwoods. Like its associates, the aspens, paper birch is a short-lived, early successional species.

In 1996, northern Wisconsin's paper birch growing stock volume was 719 million cubic feet. This was a 20% decrease from the 900 million cubic feet of growing stock in 1983. Paper birch average net annual growth between 1983 and 1996 was 6.7 million cubic feet; average annual removals were over three times average net annual growth at 20.5 million cubic feet.

Like aspen, paper birch is susceptible to many damaging agents. Since white birch is less prolific than aspen, these impacts are greater. Particularly important are two insects, the birch leaf-miner and the bronze birch borer. Animals impacting paper birch are similar to those affecting aspen—deer, hare, small mammals, and sapsuckers. Most of these animals feed on seedlings, decreasing long-term regeneration. Sapsuckers, while drilling into the bark for insects, make entry wounds that are susceptible to insect invasion or infection [USDA Forest Service, 1990]. Severe weather, especially drought and windstorms, has also been an important factor in birch decline. The severe drought of 1988 and 1989, in combination with defoliation caused by the birch leaf miner and infestations of the bronze birch borer contributed significantly to the decline and mortality of paper birch between 1983 and 1996 [USDA Forest Service, 1998].

Spruce-Fir Forest Type

The Northern Mixed Forest is distinguished primarily by the prevalence of conifers. The most common conifer forest type is spruce-fir with 1.3 million acres in the northern region. Spruce-fir forests are fairly diverse and can occur in many moisture regimes. They are the most common wet forests in the north, and often surround and blend into bogs.

Important tree species in spruce-fir forests include white spruce, black spruce, balsam fir, tamarack, quaking aspen, and white pine. White and black spruce, balsam fir, and tamarack will be discussed under the spruce-fir forest type. See the preceding aspen-birch forest type discussion for more information on aspen in northern Wisconsin. White pine will be discussed in the next forest type, pine.

White Spruce: White spruce *(Picea glauca)* is an important component of spruce-fir forests of northern Wisconsin. White spruce grows in a variety of soil and moisture conditions. It generally grows on more mesic sites than black spruce.

In 1996, there were over 233 million cubic feet of white spruce growing stock in Wisconsin's northern forests, a 17% increase over 1983. A net annual average of over 11.2 million cubic feet of new growth was added between 1983 and 1996, while an average of 2 million cubic feet as harvested.

Many birds and animals find shelter in spruce stands. Red squirrels feed on white spruce. Many species of wood warblers nest in white spruce.

Windthrow, fire, and flooding are primary white spruce mortality factors. The spruce budworm is the most important insect pest of white spruce [USFS, 1990].

Black Spruce: Black spruce *(Picea mariana)* is primarily a bog species. It is very common on northern Wisconsin's wet, low-nutrient soils. Black spruce is used for timber, boxes, and sometimes pulpwood [USFS, 1990].

In 1996, there were almost 156 million cubic feet of black spruce growing stock in northern Wisconsin. This was up from 123 million cubic feet in 1983. Black spruce grew a net annual average of 2.2 million cubic feet between 1983 and 1996, an annual average of .6 million cubic feet were harvested.

Windthrow and breakage is the primary cause of mortality of black spruce in northern Wisconsin. Fire, herbivory by snowshoe hare, and spruce budworm infestation also cause mortality in black spruce [USFS, 1990].

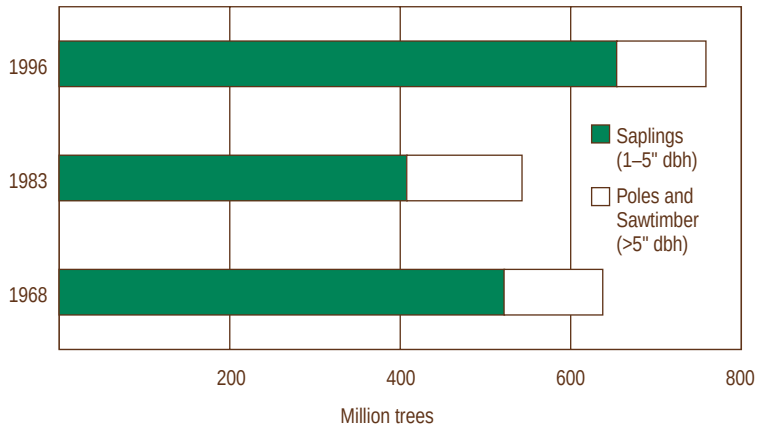
Balsam Fir: Balsam fir *(Abies balsamae)* is a common species in the northern forests. It grows on a wide variety of site types. In recent decades, balsam fir has been experiencing a decline. Forest inventory information from 1983 and 1996 shows that balsam fir growing stock volume in northern Wisconsin decreased 15%—from 552.8 million cubic feet in 1983 to 470.8 million cubic feet in 1996.

However, young trees—seedlings and saplings—are increasing and are likely to continue to increase. It is believed that balsam fir volume and forest type acreage will increase in coming decades.

Between 1983 and 1996, balsam fir in northern Wisconsin grew at a net average annual rate of almost 7.7 million cubic feet. Of that, an annual average of 5.8 million cubic feet was harvested.

Insects and disease are important mortality factors. The larger size class of large balsam fir is maturing and experiencing high mortality. Spruce budworm, windthrow, fire, and some animals (deer, snowshoe hares, red squirrels, and black bear) damage balsam fir.

Balsam fir is used for pulpwood and lumber. It is also an important species for wildlife shelter.



Common plants in spruce-fir forests

Woody plants

- beaked hazelnut *(Coryluc cornuta)*
- mountain maple *(Acer spicatum)*
- Labrador-tea *(Ledum groenllandicum)*
- Canada yew *(Taxus canadensis)*
- raspberry *(Rubus* spp.)
- sheep-laurel *(Kalmia angustifolia)*
- speckled alder *(Alnus rugosa)*
- red-osier dogwood *(Cornus stolonifera)*
- bog-rosemary *(Andromeda glaucophylla)*
- leatherleaf *(Chamaedaphne calyculata)*
- bog-laurel *(Kalmia polifolia)*

Non-woody plants

- twinflower *(Linnaea borealis)*
- bunchberry *(Cornus canadensis)*
- starflower *(Trientalis borealis)*
- creeping snowberry *(Gaultheria hispidula)*
- sedges *(Carex* spp.)
- common wood sorrel *(Oxalis montana)*
- yellow bead lily *(Clintonia borealis)*
- cinnamon fern *(Osmunda cinnamomea)*
- sweet-scented bedstraw *(Galium triflorum)*
- Canada mayflower *(Mianthemum canadensis)*
- spinulose wood fern *(Dryopteris spinulosa)*
- feathermosses *(Hylocomium splendens, Pleurozium scheribi, and Ptilium cristscastrensis)*
- sphagnum moss *(Sphagnum* spp.)

Figure 13

Balsam fir size classes

Robert Queen

Tamarack is an important wetland species in northern Wisconsin. Unlike other conifers, in autumn tamarack lo ses it's needles.

Tamarack: This distinctive conifer, turning a blazing gold in autumn and dropping its needles, is common in wet areas in northern Wisconsin. Tamarack *(Larix laricina)* is not an important timber species, although there is some use made of it for pulpwood. It is, however, an important wildlife species. Porcupines, hares, sparrows, warblers, and osprey live in tamarack bogs [USFS, 1990]

Tamarack growing stock volume has almost doubled over the last inventory period. In 1983, there were about 118 million cubic feet of tamarack growing stock in northern Wisconsin. In 1996, that figure increased to 243.46 million cubic feet.

Between 1983 and 1996, a net average annual growth of 5.4 million cubic feet was added to tamarack volume growing in northern Wisconsin. On average, less than .4 million cubic feet were harvested annually.

Tamarack is susceptible to fire, flooding, and windthrow. Porcupines and other animals may damage tamaracks by feeding.

Darrell Zastrow & David Schultz

Northern white cedar is having problems regenerating due to whitetail deer and snowshoe hare herbivory. Animals eat seedlings like this one.

Northern White Cedar: Northern white cedar, or arbor vitae—tree of life—is a common northern Wisconsin species. It is especially found around northern lakes in peatland bogs, usually alkaline. Northern white cedar *(Thuja occidentalis)* is not an important timber species, but it is used for posts and craft products. It is very important to wildlife, especially deer and elk in winter [Johnston, 1990]. Cedar forests also support many rare plants and animals.

In 1996, there were 600 million cubic feet of northern white cedar growing stock in northern Wisconsin. This was an increase over the 465 million cubic feet growing stock volume measured in 1983. Average net annual growth between 1983 and 1996 was over 10 million cubic feet; average annual removals were .8 million cubic feet.

Northern white cedar is susceptible to flooding, fire, windthrow, winter cold damage, and road salt damage. Whitetail deer and snowshoe hare herbivory can also impact northern white cedar, limiting regeneration [USFS, 1990]. There are few insect or disease problems with northern white cedar.

Pine Forest Type

Seven percent (802,000 acres) of the Northern Mixed Forest in Wisconsin is pine forest type. Red pine, eastern white pine, and jack pine are the common pine species that occur in Wisconsin. Forest character can vary from jack pine barrens, to red pine plantations, to thick stands of young white pine, to old growth stands with pines hundreds of years old. Other than pines, common associates of pine forests are quaking aspen, paper birch, balsam fir, red maple, white spruce, northern pin oak, and northern red oak. Only pine species will be discussed in this section.

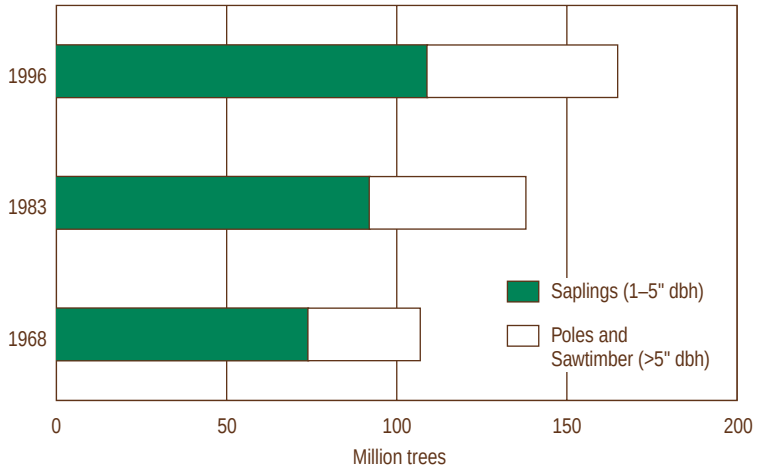
Robert Queen

Eastern white pine is making a come-back in the northern forests. Along with the bald eagle, it is once again an important part of Wisconsin's landscape.

Eastern White Pine: One of the largest and longest lived of Wisconsin's tree species, eastern white pine *(Pinus strobus)* historically played an important role in the northern forests. During the Cutover, almost all large white pine in Wisconsin was harvested. Since then natural regeneration as well as planting has resulted in white pine's resurgence.

Eastern white pine is used for many products, including furniture, pulp and paper. Many species of wildlife use white pine for food and or shelter. White pine makes a good urban tree, and is widely planted. It can also make attractive Christmas trees [USDA Forest Service, 1990].

In 1996, there were 722 million cubic feet of eastern white pine growing stock in Wisconsin's northern forests. This was up from 457 million cubic feet in 1983.



Common plants in pine forests

Woody plants

- blueberries *(Vaccinium* spp.)
- sweetfern *(Comptonia perigrina)*
- bearberry *(Arctostaphylos uva-ursi)*
- American hazelnut *(Corylus cornuta)*
- beaked hazelnut *(Corylus americana)*
- dwarf bush-honey-suckle *(Diervilla lonicera)*
- New Jersey tea *(Ceanothus americanus)*
- Fly honeysuckle *(Lonicera canadensis)*
- serviceberries *(Amelanchier spp.)*
- raspberries *(Rubus* spp.)
- trailing arbutus *(Epigaea repens)*
- wintergreen *(Gaultheria procumbens)*
- partridgeberry *(Mitchella repens)*
- dogwoods *(Cornus* spp.)

Non-woody plants

- bracken fern *(Pteridium aquilinum)*
- clubmoss *(Lycopodium* spp.)
- wild sarsaparilla *(Aralia nudicaulis)*
- Jack-in-the-pulpit *(Arisaems atrorubens)*
- Canada mayflower *(Mianthemum canadensis)*
- cow wheat *(Melampyrum linaere)*

Common wildlife in pine forests

- Yellow-bellied sapsucker
- Black-capped chickadee
- White-breasted nuthatch
- Pine warbler
- Pine grosbeak
- Red crossbill
- Beaver
- Snowshoe hares
- Porcupine
- Red and gray squirrels
- Mice
- White-tailed deer

Figure 14

White pine size classes

Robert Queen

Red pine volume increased over 250 million cubic feet between 1983 and 1996. Red pine bark.

Robert Queen

Pine forests account for 7% of northern Wisconsin's forests. White pine, Northern Highland-American Legion State Forest.

Between 1983 and 1996, there was a net annual average of 19.9 cubic feet of growth of eastern white pine in Wisconsin's northern forests. During the same period, an average of 8.6 million cubic feet were harvested annually.

Damaging agents of white pine include fire, herbivory, air pollution (ozone and sulfur dioxide), white pine blister rust, white pine weevil, and Armillaria root disease. There are other insects and diseases that affect white pine, as well, although most others have negligible impact [USFS, 1990].

Red Pine: Red pine *(Pinus resinosa)* is an ecologically and economically important species. Red pine is important to the pulp and paper industry, and mature stands with good structure often provide valuable wildlife and aesthetic benefits. Red pine is used for lumber, poles, railway ties, boxes, pulpwood, fuel, erosion control, and Christmas trees [USDA Forest Service, 1990].

Red pine is most common in dry to very dry forests [Spencer, et. al., 1988].

Between 1983 and 1996, red pine growing stock in northern Wisconsin increased from 511 million cubic feet to 779 million cubic feet.

Red pine plantations statewide increased by 150,300 acres over the inventory period. Of all red pine forest type in the state, 88% is in plantations, an increase from 79% in 1983. Although there has been an increase in red pine forest type, naturally regenerated red pine forests have decreased 26% since 1983.

Between 1983 and 1996, red pine grew at a net average annual rate 33.7 million cubic feet in northern Wisconsin. On average, about 20% of this growth, or 6.6 million cubic feet, was harvested annually.

Red pine is less susceptible to damaging agents than its associates. However, severe weather, fire, herbivory, insects, disease and road salt can injure red pine and cause mortality [USDA Forest Service, 1990].

Jack Pine: Jack pine *(Pinus banksiana)* grows most often in dry to very dry forests and in barrens.

During the last inventory period, between 1983 and 1996, jack pine growing stock volume in northern Wisconsin decreased by 38% to 98.5 million cubic feet. In 1983, there were 359 million cubic feet of jack pine growing stock in the Northern Mixed Forest. In 1996, that figure was 260 million cubic feet.

Between 1983 and 1996, jack pine grew at a net annual rate of 5.7 million cubic feet. During the same period, almost 10 million cubic feet—1.75 times the amount of growth—were harvested annually from northern Wisconsin.

Jack pine's decrease in acreage and volume is primarily a result of aging coupled with forest pest infestations, particularly jack pine bud worm, and limited natural regeneration, in part due to the absence of fire. There has also been a decrease due to the loss and conversion of the pine barrens and forests in the northwest and central parts of Wisconsin to red pine plantations or farmland. Jack pine forest type acreage between 1 and 20 years old is down from 117,000 acres in 1983 to 60,000 acres in 1996 statewide.

Jack pine also appears to be more dispersed among forest types than in 1983, impacting resource availability and operability of harvest.

Jack pine is a short-lived, early successional species. It is susceptible to many damaging agents including fire, drought, flooding, herbivory, insect damage, and disease. Fire, or similar disturbance such as clear-cutting combined with soil disturbance, is also required for its successful regeneration.

Jack pine can be important for wildlife like deer and hares. Jack pine forests often provide the best opportunity for wild blueberry picking in the Northern Mixed Forest [USDA Forest Service, 1990]. Although decreasing, jack pine is an important Wisconsin species for wildlife.

Eric Epstein

Jack pine barrens are a rare ecosystem in Wisconsin's northern and central regions. Adams County.

DNR Photo Archives

Black-capped chickadees are common in pine forests.

Robert Queen

Blueberries are especially common in sandy soiled pine forests.

Robert Queen

Jack-in-the-pulpits are found in many forests, on mesic and wet-mesic sites.

Robert Queen

Prickly pear, an unexpected sight for many in Wisconsin, occurs in pine barrens on sandy, well-drained soils.

Common plants in pine and oak barrens

Trees

- jack pine *(Pinus banksiana)*
- northern pin oak *(Quercus ellipsoidalis)*
- red pine *(Pinus resinosa)*
- quaking aspen *(Polulus tremuloides)*
- bigtooth aspen *(Populus grandidentata)*
- white oak *(Quercus alba)*

Other plants (woody and non-woody)

- sweetfern *(Comptonia perigrina)*
- New jersey tea *(Ceanothus americanus)*
- bearberry *(Arctostaphylos uva-ursi)*
- lead plant *(Amorpha canescens Pursh)*
- grasses (many genus)
- sedges *(Carex* spp.)

Wildlife in pine and oak barrens

- rufous-sided towhee
- northern flicker
- vesper sparrow
- lark sparrow
- orchard oriole
- Brewer's blackbird
- eastern hognose snake
- prairie skink
- northern brown snake
- eastern mole
- thirteen-lined ground squirrel
- prairie deer mouse

Pine and Oak Barrens

In past assessments, pine and oak barrens were not discussed. However, today they are receiving increased attention as unique ecosystems. Barrens are plant communities that occur on sandy soils and are dominated by grasses, low shrubs, small trees, and scattered large trees. Oak and pine barrens occur in northwestern and northeastern Wisconsin, and also in the Central Sands area, within and south of the tension zone. Wisconsin's Natural Heritage Inventory lists barrens communities as globally imperiled [DNR, 1999]. Most barrens exist in isolated fragments on protected state or federal land.

Changes in Tree Composition and Abundance

The northern forests have experienced many changes in composition and relative distribution over the last 150 years. In the 1850s much of the land north of the tension zone was forested with primary, old forests [Finley, 1976]. Sixty years later, nearly all had been cut over [WCD, 1955]. By the 1950s, much of Wisconsin's forests had been re-established but were still quite young. In 1996, although forests in the northern part of the state had reached a similar coverage as in the 1850s, notable compositional, functional and structural changes had occurred.

One of the most notable differences between today's forest and that of the 1850s is diminished importance of conifers. At the time of European settlement, sugar maple shared its dominance of the Northwoods with eastern hemlock. Although eastern hemlock is occasionally found in association with sugar maple, it has been reduced to an estimated 1% of its historical abundance [Eckstein, 1999].

White pine was a fairly common, and occasionally dominant, forest tree in the 1850s. Today in many areas it is nearly absent as a dominant overstory species. However, since the 1983 inventory, there is evidence of white pine recovery with abundant seedlings and saplings on many sites.

Red pine communities (vs. plantations), northern white cedar, and tamarack are also less common today. However, since 1968, red pine and tamarack volume has been increasing. Snowshoe hare and whitetail deer herbivory prevents similar recovery of northern white cedar [USFS, 1990].

Forest succession has continued since the Cutover. In the 1930s, aspen-birch was by far the most common forest type. Since then, as aspen-birch acreage has decreased, maple-beech-birch has increased. In 1996, the relative status of the two forest types was nearly opposite to that in the 30s

Barrens have experienced a decrease since European-American settlement began. This is due to decreased incidence of fire. Significant portions of the central and northwest sands areas of the state were once periodically covered in jack pine forest and barrens. These tree-dominated communities intermingled and alternated with grass- and forb-dominated openings. Openings succeeded to jack pine dominated communities, lasted for a few decades, only to be subjected again to the regressive effects of insects and fire.

With increased human population it became important to suppress fire to protect human safety and property. Since efforts at fire suppression have been successful, perhaps since the 1940s, areas that were historically jack pine forests and barrens communities have succeeded to mixed forest communities. Other areas have been converted to red pine plantations. This has led to a

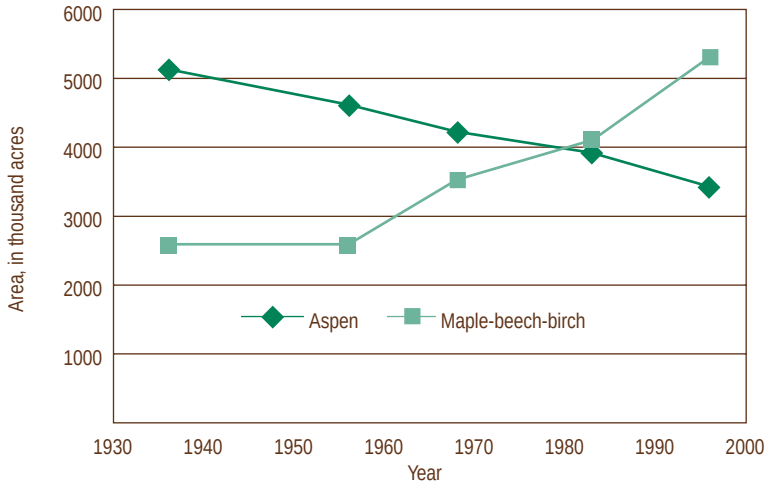


Figure 15

Aspen-birch and Maple-basswood over time

significant decrease in the barrens type community and a corresponding decline in the plants and animals associated with them [Epstein, 1998]. Jack pine forests have reached maturity and have been harvested or become senescent and susceptible to various pests and diseases. The jack pine budworm has been especially important in the recent decline and mortality of this species in Wisconsin [USDA, 1997]. Without fire or similar disturbance, many jack pine forests are being replaced by hardwood species or being converted to red pine plantations.

Biodiversity

Note: Most of the information in this section is derived from an ecological assessment of the northern forests prepared to support northern State Forest master planning [Wisconsin Department of Natural Resources, 1999]. No similar assessment has yet been conducted for the southern part of the state.

The Northern Mixed Forests—those forests north of the tension zone—have retained much of the diversity present before the Cutover. The concerns regarding biodiversity in the northern region of the state focus on community composition, structure, and function, and on specific species of concern. The overall species richness is present, although the relative abundance of many species has been greatly altered. As development of land progresses, fragmentation is a growing concern. Some ecosystems and many individual species in the Northern Mixed Forest will require management attention to protect them into the future.

Robert Queen

Since the cutover, coniferous trees are less common in Wisconsin's Northern Mixed Forests.

Robert Queen

Maple-basswood forest types, like this young maple forest, are replacing aspen-birch forest types as Wisconsin's forests age.

Ridges

Sundew is an interesting plant occurring in northern wetlands. Plant diversity in the Northern Mixed Forest is abundant, with about 1,800 vascular plants.

Ecosystem Diversity

Presettlement forest composition, structure, and function have been greatly altered by humans. The composition is the variety of tree species that occurred in the forest at the time of presettlement. The structure refers to the physical arrangement of trees, other vegetation, and the now-living components of the forest, including coarse weedy debris in the form of dead snags or fallen trees and limbs. The function of forests refers to the various interactions between living organisms and non-living components. These interactions affect ecological processes such as the decomposition of vegetation, the forming of soil, the flow of water through the system, and the filtration of air and water.

An example of these interactions is found in the changes in the mixed coniferous-deciduous forests, which show a significant reduction in coniferous component. Early logging in the north focused on pine. The white pine seed source was dramatically reduced, and the slash left on the ground after logging fueled intense fires, typically eliminating the present advanced regeneration of pine. Most of the area that was white pine forest before the intense harvests of the late 19th century is today covered in oak, red maple, white birch, and/or aspen. The replacement of a mixed coniferous forest with primarily hardwoods greatly changes composition and structure. Until recently, white pine regeneration was severely limited. However, there is currently evidence to suggest that white pine may be recovering to some extent. This regeneration process reflects a change in function.

Eastern hemlock was harvested in a second wave of logging to provide the tanning industry with bark for processing hides. Much of the hemlock component was removed from the northern forests, and now only occurs sporadically in second growth hardwood stands.

In addition to the pine and hemlock, hardwoods were also removed during the Cutover. Although clearcutting and high grading were practiced, many

hardwood species had competitive advantages over conifers. For example, sugar maple seeds' germination requirements are less demanding (colder germination temperature) than conifers', and they were able to regenerate more successfully. Many hardwood species also have the ability to sprout new growth from their roots, unlike the conifers.

The relative importance of hardwood species has also changed significantly in many stands. While sugar maple has retained or increased its dominant position, yellow birch is much less common than it once was. On the other hand, basswood and white ash are now the most important associates of sugar maple, although they were seldom listed as such by early surveyors.

The distribution of forest types, representing different seral stages of the forest, has also been significantly altered by human impact. Seral stage refers to the stages of development of an ecosystem, from very early pioneer plant and animals communities to older, later successional communities. For example, aspen, a pioneer species and an early successional forest type, is well represented and currently covers over 18% of the forestland in the state, most of which is in the north. In early surveyors' work, aspen was regularly mentioned with a variety of forest types, but rarely as a dominant so widely represented in the landscape.

In comparison, barrens, another early successional community type, is very rare. The advent of agriculture and the removal of fire from the landscape combined to convert this ecosystem to other forest types and land uses.

In contrast to these early successional forests, many hardwood mid-successional to late-successional stages are well represented in Wisconsin's northern forest. Diverse structural attributes, such as larger heights and diameters or coarse dead woody debris are still developing in these mid- to late-successional forests.

Plant Diversity

The vegetation of northern Wisconsin is a primary source of the state's biodiversity. Of the state's 2,300 vascular plants, about 1,800 occur in the northern forest region. Statewide, approximately 22% of plant species are introduced exotics. Thus, there are about 1,400 native plant species that occur in the northern forest region [DNR, 1995].

Trees, being the dominant vegetations of any forest, are crucial to the forest's biodiversity. There are approximately 30 tree species that occur in the northern forests of Wisconsin, although no more than about 10 are found together in any given ecological community.

There are 59 plants in the northern forest region that are endangered, threatened or species of concern (see Appendix 2). These plants will likely require some management attention in order to preserve them within Wisconsin.

Animal Diversity

Of the 327 vertebrate species present in Northern Wisconsin, 273 are believed to have secure futures in the state. Fifty-four are believed to require management to protect and preserve them into the future [DNR, 2000].

The richness, distribution and abundance of animals in the northern forests have changed significantly. Among mammals, historically unregulated commer-

Northern Wisconsin forest and barrens species requiring management attention

Mammals

- star-nosed mole
- fisher
- Franklin's ground squirrel
- woodland jumping mouse
- black bear
- arctic shrew
- plains packet gopher
- gray wolf

Birds

- cerulean warbler
- black-throated blue warbler
- wood thrush
- Connecticut warbler
- veery
- blue-winged warbler
- rose-breasted grosbeak
- Canada warbler
- chestnut-sided warbler
- blackburnian warbler
- bay-breasted warbler
- American woodcock
- eastern wood pewee
- Louisiana waterthrush
- mourning warbler
- black-billed cuckoo
- least flycatcher

Herptiles

- four-toed salamander
- bull snake
- copes gray tree frog
- smooth green snake

DNR Photo Archives

Fishers were once extirpated from Wisconsin. They have returned to the state and are now fairly common forest predators.

Robert Queen

Wolves are important predators in our forests. Wolf populations in the state are increasing.

cial hunting and trapping as well as dramatic habitat changes resulted in extirpation of some formerly important game species. Unregulated hunting was also responsible for the loss of large carnivores in the northern forests as well as a number of grazers. Eastern timber wolf, wolverine, fisher, pine marten, and eastern cougar were the most severely affected carnivores. Affected herbivores include elk and moose [DNR, 1995]. Recovery of some of these species is underway. Over-hunting also contributed to the demise of some bird species. Perhaps the most renowned example was the extinction of the passenger pigeon.

The second important factor in many species' change in abundance was, and continues to be, loss of habitat. Currently, for most animals, this is a more severe threat than hunting. Permanent habitat loss caused by urban encroachment, road building, and lakeshore/rural development is a very serious issue. Generally, forest habitats need to be maintained as forests to remain viable habitat for forest-dwelling species. The compositional and structural characteristics of the forest provide the habitat niches for species that are forest-dependent. Some of these species are very specialized in their habitat requirements. A variety of bird species, for example, typically prefer discrete nesting sites in a particular part of a tree, or in the shrub layer in an understory, or on the ground. Another example would be the many species of frogs and salamanders requiring forest ponds, or decaying logs on the forest floor, or a thick litter layer to provide habitat for their different life stages.

Kuesehke

There are many organisms living in our forests that we have yet to understand well. Lichens (pictured), fungi, bacteria and invertebrates, for example, are fundamental components of forest ecology and require further study.

Other Life

Although there is near universal acknowledgment of their importance, invertebrates, non-vascular plants, fungi, bacteria, and other small species have been largely overlooked in most of the research and planning regarding biodiversity. It is estimated that fungi alone may account for 12–30 thousand species in Wisconsin, few of which have been described. Fungi are extremely important in nutrient cycling and ecosystem functioning.

Except for pest species, little research has been directed at forest invertebrates. Lack of knowledge in this area is a concern since invertebrates are a very diverse group and perform important ecosystem functions, such as the breakdown of dead vegetation, the soil formation process, and predator-prey interactions. There has been even less research directed toward non-vascular plants and protozoa.

It is hoped that by sustaining a full array of community compositional and structural attributes, plants, and animal species, these associated organisms will also be sustained. However, it is clear that more research is needed to better understand the diversity and function of these organisms in Wisconsin's forests.

Dorothy Ferguson

Savanna, prairie, and forest are all important ecosystems in the Southern Broadleaf Forest region of Wisconsin. Savanna, Devil's Lake State Park.

Southern Broadleaf Forests

Ecological Capability

The southern region is located in the area south of the tension zone. Glaciers covered about half of the Southern Broadleaf Forest region of Wisconsin. Extensive glacial features like steep moraines, deep kettles, droughty outwash plains, and layered glacial lake deposits blanket the glaciated area. The well-known Kettle Moraine in the southeast is one of the more pronounced moraine systems found in the area. Because this steep terrain limits urban and agricultural development, forests are more common on the Kettle Moraine than on the surrounding landscape.

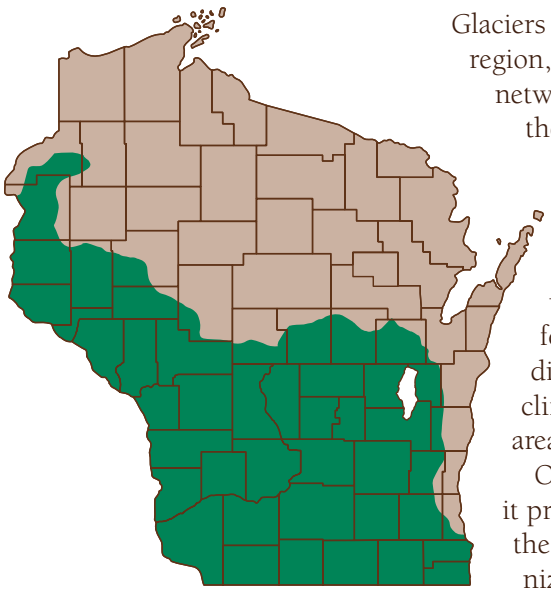
As in the north, many lakes and ponds formed by means of glacial activity. Glaciers scoured the beds of Lake Winnebago and other larger lakes in the region, as well as Lake Michigan. In addition, there is an extensive riparian network in the Southern Broadleaf Forest. Streams, creeks, and rivers drain the southern region into Lake Michigan and the Mississippi River. Lowland elm, oak, maple, birch, cottonwood and ash forests grow along the rivers and streams.

The other half of the Southern Broadleaf Forest region remained unglaciated, and is therefore called the Driftless Area. *Drift* is a term used to describe the material moved by a glacier that becomes the base for subsequent soil development. The coulee topography here is much different from the other half of the Southern Broadleaf Forest. Ancient cliffs, deep winding valleys, and the steep Baraboo Hills characterize this area.

One of the reasons the Driftless Area is significant ecologically is because it provided plant and animal habitat throughout the glacial period. During the glacial period, this area sheltered many species that eventually colonized the glaciated areas of Wisconsin after the glaciers receded.

Figure 16

Wisconsin's Southern Broadleaf Forest.



The climate of the Southern Broadleaf Forest is warmer than in the north. Average temperature in the Southern Broadleaf forest is between 43 to 52 degrees Fahrenheit. Average high daily temperature in August is generally in the low 80s, and average daily low temperatures in January are in the single digits. Areas near Lake Michigan experience a distinct moderation, with their average variance between August and January temperatures as much as 15 degrees less than inland areas.

Precipitation ranges from 25 to 35 inches. In the glaciated area, about two-thirds of the precipitation falls during the growing season. In the Driftless Area only about 40% falls during the same frost-free period. Although snow is abundant, it is not as plentiful as in the Northern Mixed Forest area. In Beloit, the average snowfall per winter averages 30 inches. In Wisconsin, average annual snowfall tends to increase moving north, at higher elevations, and near the Great Lakes. Snow provides valuable insulation to plants and animals.

Soils in the Southern Broadleaf Forest were formed under prairie, savanna, or forest—or all three, as there was often a dynamic progression between the three vegetation types at a site. For the most part fertile and tillable, much of Wisconsin's southern region has been converted to agriculture. Soils in the Driftless Area tend to vary more than in areas where glacial till is the parent material. The varied topography in the Driftless Area influences the soils, vegetation, and even climate at local scales. Soils on steep slopes tend to be less developed and thinner than bottomland soils—less fertile and more challenging for vegetation. Loess deposits are frequently found on ridgetops. A large area of sandy soils in central Wisconsin—called the Central Sands—is included in the Southern Broadleaf Forest. These soils originated from the glacial outwash from the north. These soils tend to be droughty and infertile. The areas tend to be susceptible to fire due to less moisture and vegetation associated with fire disturbances.

DNR Photo Archives

Raccoons are very common throughout southern Wisconsin's forests.

Robert Queen

The Baraboo Hills is one of the few large forest tracts remaining in Wisconsin's Southern Broadleaf Forest. The steep slopes prevented these hills from being converted to agriculture.

Common wildlife species in Wisconsin's Southern Broadleaf Forest

Mammals

- white-tailed deer
- beaver
- muskrat
- raccoon
- skunk
- coyote
- red fox
- red and gray squirrels

Birds

- various hawks
- sandhill cranes
- quail
- grouse
- wild turkey
- Canada geese
- many songbirds

Reptiles and amphibians (herptiles)

- American toad
- tiger salamander
- fox snake
- garter snake

DNR Photo Archives

Wildlife like the ever-present gray squirrel thrive on the nuts provided by oak-hickory forests

The Southern Broadleaf Forest region is very urbanized, especially in the eastern area. Much of the remaining area in the region supports agriculture. The southern region of Wisconsin is more attractive for settlement and agriculture because it is more fertile and experiences less severe winters than the northern area of the state. Forests are mostly limited to steeper slopes, shallow poor sites, and very dry or wet sites.

Current Status of Wisconsin's Southern Broadleaf Forest

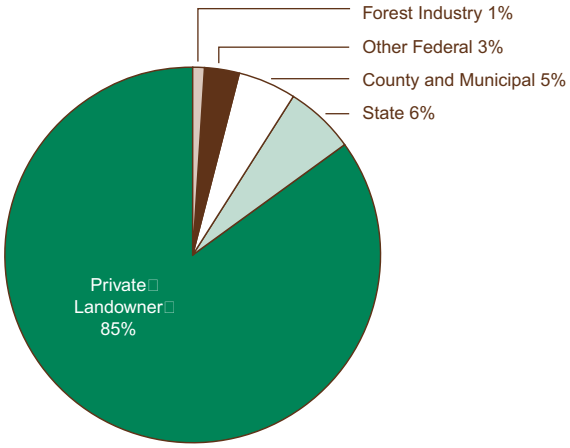
About 27% of the Southern Broadleaf Forest region is actually forestland. Most of the remaining land-use is agriculture or developed urban areas. A little less than 30% of Wisconsin's forests occur in the southern region, although the region contains almost 50% of the total land area in the state. This is primarily due to potential forestland in southern Wisconsin currently used for agriculture or urban development.

Private individual owners own almost 85% of the Southern Broadleaf Forest. The state owns just 6% of the forestland in southern Wisconsin. County and municipal forests account for 5% and federal lands account for just 3% of the total forestland in southern Wisconsin. Ownership differences between the southern and the northern forest regions are dramatic. The primary difference is the lack of public ownership of forests in the south. Another major difference is that, in the southern region, forestland is held in much smaller parcels. The average forest parcel size in southern Wisconsin is less than 40 acres.

Most of the Southern Broadleaf Forests of Wisconsin are located in the central and southwest areas of the state. Due to agricultural and urban development, the southeast contains little forestland. The largest blocks of forest occur in the Central Sands region as well as in the Driftless Area of the southwest. Large

Figure 17

Wisconsin's Southern Broadleaf Forest ownership



blocks include the Central Sands, the Baraboo Hills, the northern unit of Kettle Moraine State Forest, and forest along the Wisconsin, Chippewa, Black and Kickapoo Rivers.

The most common forest type in the Southern Broadleaf Forest is oak-hickory. It represents about 46% of the forests in the southern part of Wisconsin. Primary tree species in oak-hickory forests include northern red oak, white oak, burr oak, northern pin oak, black oak, red maple, aspen, shagbark hickory, basswood, white pine and black cherry.

About a quarter of the forests in the Southern Broadleaf Forest are maple-basswood forest type. Species composition is similar to the northern maple-basswood forest, with sugar maple and basswood being the dominant species. However, there is decreased importance of hemlock, yellow birch and aspen and the increased importance of oaks as compared to the northern maple-basswood forests.

The elm-ash-cottonwood forest type generally is a lowland type that makes up a higher percentage of the southern than northern forests. However, the Northern Mixed Forest contains a larger net acreage of elm-ash-cottonwood forest type. Important species in this forest type are black ash, white ash, silver maple, and red maple. Other forest types of note are aspen-birch, red pine, white pine, and jack pine.

The Southern Broadleaf Forest can be distinguished from the Northern Mixed Forest by the predominance of oak species, as well as by the presence of other species whose range is restricted to areas south of the tension zone such as shagbark hickory, hackberry, and black walnut. For the most part, barring the Central Sands' pine forests and barrens, the forests of the southern region lack a coniferous component (eastern red cedar being an exception). However, microsites containing white and red pine and even hemlock are found in parts of the Driftless Area.

Although not a tree-dominated ecosystem, oak savanna will also be discussed within the context of the southern forest region.

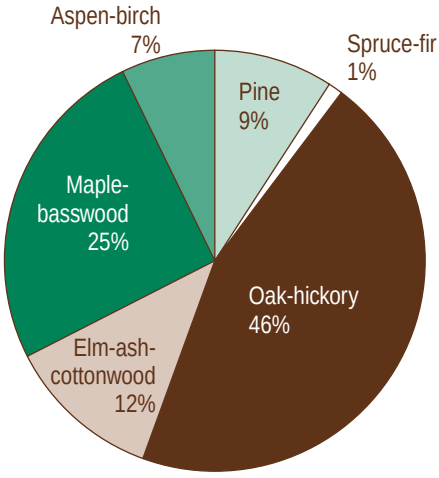


Figure 18

Southern Broadleaf Forest types

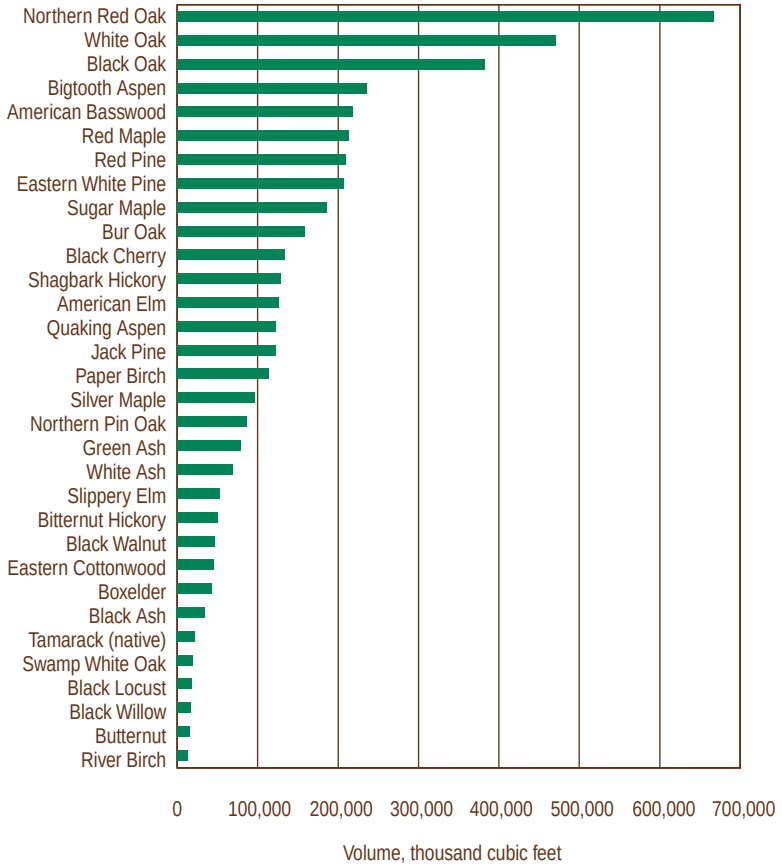


Figure 19

Volume of Wisconsin's Southern Broadleaf Forest, by species

Table 2: Forest types of Wisconsin's Southern Broadleaf Forest

Forest Type	% of Wisconsin's Southern Broadleaf Forest	Characteristic tree species
Oak-hickory	46%	northern red oak *(Quercus rubra)* white oak *(Quercus alba)* northern pin oak *(Quercus ellipsoidalis)* bur oak *(Quercus macrocarpa)* black oak *(Quercus velutina)* shagbark hickory *(Carya ovata)* quaking aspen *(Populus tremuloides)* basswood *(Tilia americana)* white pine *(Pinus strobus)* bitternut hickory *(Carya cordiformis)* red maple *(Acer rubrum)* black cherry *(Prunus serotina)*
Maple-basswood	25%	red maple *(Acer rubrum)* sugar maple *(Acer saccharum)* American basswood *(Tilia americana)* northern red oak *(Quercus rubra)* black cherry *(Prunus serotina)* white ash *(Fraxnus americana)* white oak *(Quercus alba)* shagbark hickory *(Carya ovata)*
Elm-ash-soft maple	12%	American elm *(Ulmus americana)* red maple *(Acer rubrum)* black ash *(Fraxinus nigra)* white ash *(Fraxinus americana)* cottonwood *(Populus deltoides)* willow *(Salix* spp.*)* green ash *(Fraxinus pennsylvanicum)* swamp white oak *(Quercus bicolor)* silver maple *(Acer rubrum)* riverbirch *(Betula nigra)* quaking aspen *(Populus tremuloides)*

Common plants in oak-hickory forests

Woody plants

- American hazelnut *(Corylus cornuta)*
- common blackberry *(Rubus* spp.)
- gray dogwood *(Cornus racemosa)*

Non-woody plants

- blue marsh violet *(Viola cucullata)*
- lady fern *(Athyrium felix-feminina)*
- false Solomon's seal *(Smilacina racemosa)*
- hog-peanut *(Amphicarpaea bracteata)*
- wild geranium *(Geranium maculatum)*
- wild strawberry *(Fragraria virginiana)*
- interrupted fern *(Osmunda claytonia)*

Oak-Hickory Forest Type

Oak-hickory forests are havens for "nut-loving" wildlife. These forests produce valuable timber, provide much of the southern region of Wisconsin with recreational opportunities ranging from hiking to hunting, and perform essential ecological functions.

Many of the state's current oak forests are a result of land management practices following European-American settlement, including clearing, short-term intense fires, and farming. The frequent fires and resultant open conditions after the Cutover favored oaks over more shade-tolerant species. Since then, these areas have matured and become dense oak forests. For the most part, fire has been removed from the oak forests of southern Wisconsin. Since

oak-hickory forests prefer relatively open conditions for regeneration and are tolerant of fire, the absence of fire has resulted in less oak regeneration in these forests in recent decades.

There are almost 2 million acres of oak-hickory in the southern region—46% of the total regional forest cover. Important species in the oak-hickory forest type include northern red oak, northern pin oak, white oak, burr oak, black oak, aspen, basswood, white pine, shagbark hickory, bitternut hickory, red maple, black cherry, and black walnut. This discussion will cover the oaks, hickories, black cherry, and black walnut.

Robert Queen

This open-grown burr oak is typical of the trees that grew in savannas.

Oaks: Oaks are very important commercially, ecologically, and aesthetically. There are seven species of oak that occur in the Southern Broadleaf Forest region of Wisconsin—northern red oak *(Quercus rubra)*, northern pin oak *(Quercus ellipsoidalis)*, black oak *(Quercus velutina)*, white oak *(Quercus alba)*, burr oak *(Quercus macrocarpa)*, swamp white oak *(Quercus bicolor)*, and chinkapin oak *(Quercus muehlenbergii)*. Chinkapin oak is limited to the very southern edge of Wisconsin, and has minimal volume and little harvest.

In 1996, there was 666.6 million cubic feet of northern red oak growing stock in the Southern Broadleaf Forest. During the same year, there was 469.5 cubic feet of white oak growing stock. Black oak accounted for 382.1 million cubic feet, burr oak for 157.5 million cubic feet, northern pin oak for 85.8 cubic feet, swamp white oak for 19 million cubic feet growing stock volume.

Northern red and white oak are the most harvested species in Wisconsin's southern forests. For most oak species, and especially these more common ones, harvest is far exceeding growth in southern Wisconsin.

There has also been less oak regeneration than in the past. As people harvest the maturing oaks, some are choosing to harvest only the best quality trees and to leave the smaller, undesirable trees, a practice called *high-grading*. The shady and shrubby growing conditions in these high-graded forests favor shade-tolerant species like maples, ash, hickory, cherry, elm, ironwood and basswood rather than oaks. Another associated problem is that in high-graded stands there may not be enough viable seed source for regeneration because all the commercially desirable species, like oaks, have been removed. This situation often results in a forest of poor-quality mixed hardwoods. With the lack of fire, these hardwoods quickly capture the site. Lots of sunlight and limited plant competition are required for good oak regeneration and establishment.

Size class data can illuminate the oak regeneration situation somewhat. The data here is statewide data, however, the following are applicable to the

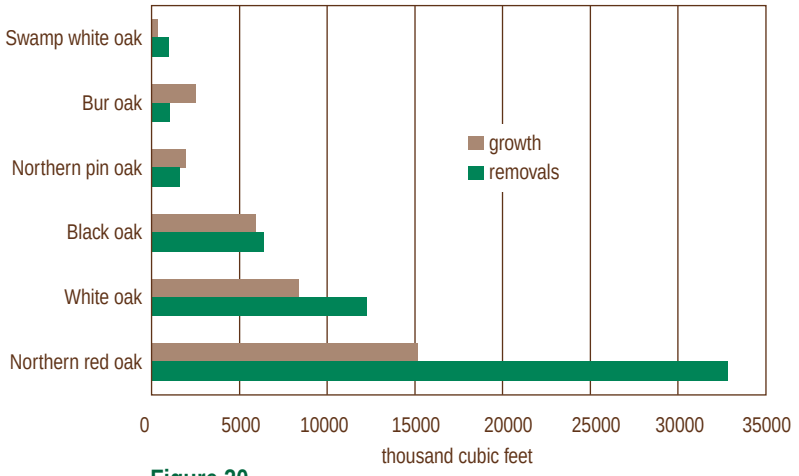


Figure 20

Growth and removals of southern Wisconsin oaks, 1996

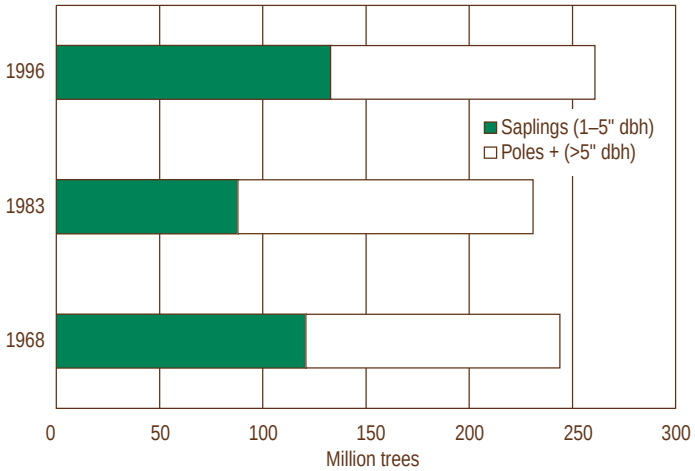


Figure 21

Red oak size classes

DNR Photo Archives

Northern red oak is the most common oak species in Wisconsin.

DNR Photo Archives

Northern red and white oaks are the most harvested of Wisconsin's southern species. Harvest exceeds growth in these species in southern Wisconsin.

DNR Photo Archives

The future of oak regeneration is unclear in Wisconsin's southern forests.

southern oak population. With the exception of northern pin oak, all species of oak have increased their volume in Wisconsin's Southern Broadleaf Forest over the last inventory period (1983–1996). However, combining this information with southern Wisconsin's large harvest:growth ratio, the future of oak in Wisconsin's Southern Broadleaf Forest is unclear. Stand-age class information for oak-hickory forests shows that over the last 15 years there has been a decline in acreage of the 1–20 year-old age class in all but the northwestern part of the state. As oak-hickory stands represent the future oak resource, in southern Wisconsin there is a concern that oak may decrease as a component in Wisconsin's southern forests.

Hickory: Wisconsin's hickories—shagbark, bitternut, mockernut, pignut, and shellbark—provide the hardest, most resilient wood of all the state's timber species. Shagbark *(Carya ovata)* and bitternut *(Carya cordiformis)* are the more common hickories in the state, the others occur only rarely. They are very valuable for wildlife. Squirrels, chipmunks, black bear, gray and red foxes, rabbits, white-footed mice, mallards, wood ducks, bobwhites, and wild turkey all eat hickory nuts. Hickory is used for products requiring strength and resilience—tools, furniture, gym equipment, etc. Shagbark hickory nuts, unlike the aptly named bitternut, are sweet, and eaten and sold by many Wisconsinites [USDA Forest Service, 1990].

In 1996, there were 49 million cubic feet of bitternut hickory, and 128 million cubic feet of shagbark hickory growing stock in southern Wisconsin. The other three species of hickory—shellbark *(Carya laciniosa)*, pignut *(Carya glabra)*, and mockernut *(Carya tomentosa)*—combined accounted for about 1.6 million cubic feet of growing stock in southern Wisconsin. Shagbark and bitternut both increased their growing stock over the 1983 figures of 112 million cubic feet and 48 million cubic feet, respectively [Schmidt, 1997].

Between 1983 and 1996, shagbark hickory grew a net annual average of 3 million cubic feet in Wisconsin's Southern Broadleaf Forest. About 14% of that growth was harvested, 442 thousand cubic feet annually. During the same time period, bitternut hickory grew a net annual average of 1.7 million cubic feet, 56%—948,000 cubic feet—of which was harvested annually [Schmidt, 1997].

Hickory is very susceptible to fire. Even low intensity fires can kill mature hickories. Hickory timber is often damaged by sap-sucker feeding which can stain the wood. The most common damaging disease of hickories is white-heart rot, although it is not a significant mortality factor for Wisconsin's hickories [USDA Forest Service, 1990].

Robert Queen

The aptly named shagbark hickory is an important species in the Southern Broadleaf Forest, and its wood is some of the strongest growing in Wisconsin's forests.

Black Walnut: Black walnut *(Juglans nigra)* is one of the most prized of Wisconsin's timber species. Its beautiful, straight-grained, strong wood is used for furniture, gun stocks, and veneer.

Black walnut nuts are eaten by a wide array of wildlife. The shells have been used for any number of interesting products, including abrasive cleaners and media for pesticide application. [USDA Forest Service, 1990].

In 1996, there were 45.7 million cubic feet of black walnut growing stock in southern Wisconsin. This was up from 22.6 million cubic feet in 1983. Between 1983 and 1996, just 12% of the 1.5 million cubic feet of average net annual growth were harvested.

Black walnut is susceptible to a number of insects. Two diseases that can impact black walnut are root rot disease, and anthracnose. Animals can cause

physical damage by browsing on young plants, or by gnawing bark. Late freezes in the spring can also damage the opening buds of black walnut [USDA Forest Service, 1990].

Because of its economic value, back walnut is growing in popularity as a plantation tree.

Black Cherry: Black cherry *(Prunus serotina)*, known for its lovely reddish wood, occurs in most of Wisconsin's mixed or deciduous upland forests. It is harvested and used for furniture or veneer. Black cherry is also important to wildlife. Songbirds, squirrels, deer, turkey, mice, moles, and other species eat the cherries in the fall. Humans also eat the fruit—generally made into jelly or wine. The bark is used for cough medicines [USDA Forest Service, 1990].

In 1996 there were 133 million cubic feet of black cherry growing stock in the Southern Broadleaf Forest, a 50% increase over the figure for 1983. Between 1983 and 1996, black cherry grew at an average net annual rate of 4.1 million cubic feet in southern Wisconsin. About half of that was harvested.

Black cherry is susceptible to a number of mortality factors. Fire will kill it, but unless it is a very hot fire, black cherry is likely to sprout from its surviving root stock. Porcupines and deer can cause damage by feeding. The eastern tent caterpillar and the cherry scallop moth are both insects that can damage black cherry trees.

Often, black cherry can be identified by the black knot fungus that causes elongated black swellings several times the diameter of an infected twig and large swellings of the trunk. Although still useful for wildlife and ecosystem functioning, black knot can make the tree unusable for commercial projects [Marquis, 1990].

Elm-Ash-Cottonwood

There are a half million acres of elm-ash-cottonwood forests in Wisconsin's southern forests. Characteristic tree species in the elm-ash-cottonwood forest type include red maple, silver maple, black ash, green ash, American elm,

John Kotar

Elm-ash-cottonwood is a lowland forest type occurring along rivers and streams in southern Wisconsin. This type includes bottomland forest types, as shown in this picture, which flood periodically

Common plants in elm-ash-cottonwood forests

Woody plants

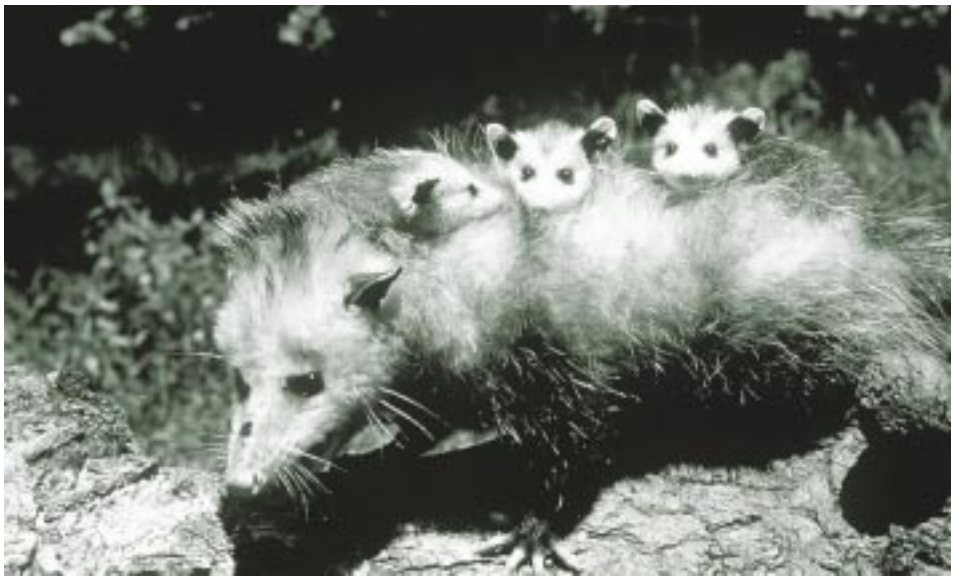
- red osier dogwood *(Cornus stolonifera)*
- buttonbush *(Cephalanthus occidentalis)*
- wild grape *(Vitis riparia)*
- Virginia creeper *(Parthenocissus quinquefolia)*
- moon seed *(Menispermum canadense)*
- wahoo *(Euonymus atropurpurea)*

Non-woody plants

- false nettle *(Boehmeria cylindrica)*
- fringed loosestrife *(Boehmeria cylindrica)*
- orange jewelweed *(Impatiens capensis)*
- wood-nettle *(Laportea canadensis)*
- green dragon *(Arisaema dracontium)*
- clearweed *(Pilea pumila)*
- sedges *(Carex* spp.)
- grasses (many genus)

Common wildlife in elm-ash-cottonwood forests

- white-tailed deer
- gray squirrel
- great blue heron
- barred owl
- red-bellied woodpecker
- red-shouldered hawk
- blue-gray gnatcatcher



DNR Photo Archives

Opossums, nocturnal marsupials, are common throughout Wisconsin, especially in the elm-ash-cottonwood forests.

quaking aspen, river birch, swamp white oak, black willow, eastern cottonwood, and boxelder. American elm—once a primary indicator of these moist, riverine forests—has been greatly reduced in Wisconsin (and the rest of the eastern United States) by Dutch elm disease.

Statewide, cottonwood, willow, balsam poplar, river birch, and black ash all have their greatest volume in the elm-ash-cottonwood forest. By volume, the most important species in the elm-ash-cottonwood forest of Wisconsin are red maple, black ash, green ash, silver maple, quaking aspen, northern white cedar, balsam fir, and American elm. Quaking aspen is discussed under the aspen-birch forest type in the Northern Mixed Forest section. Northern white cedar and balsam fir are discussed under the spruce-fir forest type heading in the Northern Mixed Forest section. Cottonwood, willow and balsam poplar contribute only small volume to Wisconsin's forests; they will not be discussed separately. The rest—red maple, the ashs, and American elm—will be discussed in this elm-ash-cottonwood forest type section.

Elm: The American elm *(Ulmus americana)* has had one of the most dismal recent histories of all of Wisconsin's tree species. Dutch elm disease was introduced to the United States in the 1930s. It is a fungus, and can be transmitted either through insects or through the roots of a neighboring tree. Although isolated large individuals and trees under 25 years old are still found in Wisconsin, there is significantly less elm in the state's forests than there once was. It is hoped that the remaining elms may have some resistance to the Dutch elm disease fungus.

In addition to the American elm, there are two other elm species in Wisconsin—the slippery elm *(Ulmus rubra)* and the rock elm *(Ulmus thomasii)*. Both are susceptible to Dutch elm disease and have experienced much the same fate as the American elm.

In 1996, there were 126 million cubic feet of American elm growing stock in the state. This was a significant increase over the 75.7 million cubic feet present in 1983. However, most elm are in very young forests as Dutch elm disease doesn't usually manifest until trees are older.

Between 1983 and 1996, American elm average net annual growth was about 6.3 million cubic feet. About 1.8 million cubic feet were harvested annually.

Ash: The three ashes—black, white, and green—vary considerably in their preferred sites and uses. White *(Fraxinnus americana)* and green *(Fraxinus pennsylvanicum)* both prefer well-drained soils, with a neutral to alkaline pH, whereas black ash *(Fraxinus nigra)* is very tolerant of a wide range of pH conditions and found with pH anywhere from 4.4 to 8.4, most often in northern Wisconsin [USFS, 1990].

White and green ash wood, resilient and strong, is used for tool handles and baseball bats [Kennedy, 1990], furniture and flooring, and is one of the most popular street trees in Wisconsin. Black ash is not generally used for lumber or other products, although some specialty products like baskets may utilize black ash [USFS, 1990]. White-tailed deer feed on twigs and seedlings of all three ash species.

In 1996, there were 34 million cubic feet of black ash growing stock in southern Wisconsin. This was a decrease of 4 million from the 38 million present in 1983. Between 1983 and 1996, white and green ash increased from 75.3 million cubic feet of growing stock to 146.6 million cubic feet.

Average net annual growth of black ash between 1983 and 1996 was about 1 million cubic feet, about half of which was harvested. During the same period, white and green ash grew a net annual average of 5.9 million cubic feet, of which 3.6 million was harvested.

Red Maple: Red maple *(Acer rubrum)* is more common now than it once was. The virtual elimination of American elm due to Dutch elm disease, and American chestnut by chestnut blight, the control of fire, combined with the selective harvest of yellow birch and sugar maple, has allowed red maple to become a dominant or common associate in many areas where it historically was not.

Although not as valued as sugar maple for timber, red maple is important to the pulp industry and is also used for furniture. It can be tapped like sugar maple, and its sap boiled into sweet, amber-colored syrup. Because of its beautiful fall leaf color and pleasant shape, red maple is often used as a landscaping tree [USDA Forest Service, 1990].

In 1996, there were 212 million cubic feet of red maple growing stock in Wisconsin's southern forests. This was an increase from the 1983 figure of 120 million. Between 1983 and 1996, about 25% of the 8 million cubic feet of net average annual growth was harvested, leaving 6 million cubic feet to add to the forest's overall volume.

Many species of wildlife use red maple for food or shelter. White-tailed deer especially browse on twigs and seedlings.

Savanna

A *savanna* is an ecosystem that is transitional between the eastern forests and the western prairies, having a mosaic of plant communities that represent a continuum from prairie to forest. Grasses and other forbs share dominance with scattered trees and shrubs. Historically, savannas were maintained by periodic fire. A number of understory species are more frequent in savannas than in either prairie or forests. Wisconsin savannas have been called, among

other names, oak openings, oak barrens and oak woodland. Currently there are approximately 500 acres of good quality oak savanna remaining in the state, with some other areas having potential for restoration [Hoffman, in press]. According to the Wisconsin's Natural Heritage Inventory, oak savanna is among the most threatened ecosystems in the world [Noss, LaRoe and Scott, 1997].

Important tree species in oak savanna are burr, black, red and white oak [Curtis, 1959].

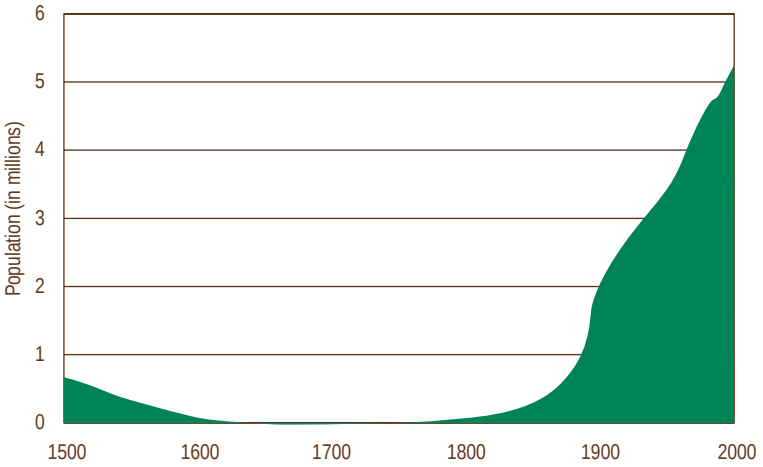


Figure 22

Wisconsin population over time

Changes in Tree Composition and Abundance

Like their northern counterparts, Wisconsin's southern forests have experienced steady change in composition, structure, and function since European settlement. Throughout that time, the area has experienced ever-increasing human population growth combined with increasing demands for resources. Meeting those demands has required converting forestland to agricultural and urban development.

Unlike the Northern Mixed Forest that was cutover in the late 1800s and early 1900s for timber, in general, the Southern Broadleaf Forest was cleared for agriculture. This distinction is important when looking at the events following the Cutover. In the north, although agriculture was attempted after the timber harvest in some areas, the land was not well-suited to most crops and the effort was abandoned. Thus, the forests were able to regenerate, and today northern Wisconsin has approximately the same area of forestland as before the Cutover. However, with the exception of marginal cropland and pastureland, southern agricultural land has been retained for crop production and has not converted back to forest, savanna, or prairie.

The most striking change that has occurred in the Southern Broadleaf Forests of Wisconsin over the last 150 years is the dramatic fragmentation of the forest. The average size of forest parcels in southern Wisconsin is only 47 acres [DNR, 1995]. The average size of privately held forest parcels is just slightly over 30 acres in southern Wisconsin [USFS, 1997]. The remaining larger areas of forest

DNR Photo Archives

The average size of a forest parcel in southern Wisconsin is 47 acres. Fragmentation is a major concern in the Southern Broadleaf Forest.

DNR Photo Archives

There are now only 500 acres of savanna remaining in Wisconsin. Historically, there were as many as 5.5 million acres.

were not converted to farms or cities by virtue of their dry, nutrient-poor soils in the Central Sands or their steep slope and resulting inaccessibility [DNR, 1995].

It is not likely that the extent of southern forested land will undergo any dramatic increase in the near future. However, the composition and distribution may well be altered. Forestland in southern Wisconsin has increased somewhat from 1968 to 1996. However, this trend may change as the population increases and there is more development pressure.

Savanna communities have experienced even more significant change than the southern region's forests. In acreage, Wisconsin's savannas have decreased

DNR Photo Archives

When fire suppression began, areas that were savanna or prairie converted to dense oak woodlands like this one.

to just one tenth of 1% of what was present in the 1850s. There was once 5.5 million acres of savanna in southern Wisconsin. There are now only about 500 acres.

In presettlement times, savannas were maintained by frequent fires and large, grazing herbivores such as bison. The climate of southern Wisconsin receives much more rain than other areas where there was historically savanna. That is one reason researchers now believe that Native Americans were responsible for fire management that maintained the savannas of southern Wisconsin. Both fire and the presence of large grazing ungulates prevented most trees from growing large and provided opportunity for grass species to flourish between scattered oak trees. When these forces were removed, the areas that were savanna were either plowed under for agriculture (the majority) or became denser oak forests (limited to old pastureland or steep hillsides), many of which have succeeded to a mixed hardwood forest.

Biodiversity

Note: Due to the lack of a regional ecological assessment for southern forests (see note on page 37), less information is available on biodiversity of southern forests than northern forests.

Southern forests and savannas have been impacted enormously by fragmentation. Those forested areas that have survived intact did so mainly because they are on dry nutrient-poor sites or on steep hillsides. Intact savanna areas are limited to protected lands. Biodiversity concerns in the southern region of Wisconsin focus on loss of habitat and ecological communities and on a number of species of concern.

Ecosystem Diversity

Almost all of the forest communities of the Southern Broadleaf Forest have experienced significant change in diversity since European-American settlement. Much of the land that is now forested in the southern region was savanna before people began to suppress fire.

One of the major differences in today's Southern Broadleaf Forests in Wisconsin and those of the 1850s is the importance of oak species. The clearing and fires of European-American settlement encouraged oaks to colonize disturbed areas. Subsequently, people removed fire from the southern region to protect lives and property. Dense oak forest grew. Currently, as forests age the shade-intolerant oaks are beginning to be replaced by more shade-loving species like sugar maple on more mesic, nutrient-rich sites.

Some areas that were formerly savanna converted to dense oak forests after the beginning of fire suppression activity. In the short-term, these areas, without a shade-tolerant hardwood seed source, will likely convert to other southern hardwoods.

A great deal of current agricultural land and the forests that remain in the southern region of Wisconsin occur on land that was formerly savanna. Savanna was first cleared for agriculture. Usually because fertility was lacking, a small portion of this land was allowed to go fallow. Without fire or grazing of large herbivores like bison, instead of reverting to its former savanna cover type a dense oak forest grew. Most of the areas that were forest before European-American settlement were more fertile and remained agricultural land [DNR, 1995].

Plant Diversity

The southern region of Wisconsin has lost a number of individual species. Many others are endangered, threatened or of special concern (see Appendix 2). Many forest and savanna plants in the southern region are threatened.

Many plant species that were probably savanna specialists are now uncommon and are found only on the fringes and openings of oak woods, brushy areas, and lightly grazed pastures. Some examples are yellow pimpernel, pale Indian plantain, woodland thistle, downy wild rye, elm-leaved goldenrod, New Jersey tea, sessile-leaved eupatorium, and horse gentian.

Animal Diversity

Almost the entire forest habitat in the southern region is in patches of less than 125 acres. However, this limited habitat seems to be supporting most of the species found at the time of European-American settlement. Some notable exceptions are the extirpation of most large carnivores and grazing herbivores (coyote and white-tailed deer being excepted). Bison, elk, cougar, and bobcat are no longer present in southern Wisconsin. Some large carnivores, such as wolves, are returning [DNR, 1995].

There have been relatively few population surveys or other studies regarding mammals in the southern forests. However, it appears that, in general, small mammals have weathered the changes in the forest community fairly well. Small mammals like mice and voles have increased, and their associated predators also seem to be doing well. Various bats and fox squirrels are some species of concern.

Although most species of birds native to Wisconsin are still present, bird populations have been impacted by the same human forces mentioned earlier—namely habitat fragmentation and loss. There are many birds that require

Dean Tvedt

Most animals, like this cottontail rabbit, have a secure future in Wisconsin's Southern Broadleaf Forest.

DNR Photo Archives

A savanna species, the ornate box turtle is endangered in Wisconsin.

large areas of forest for their habitat—at least a dozen species that require more than 40 acres, and at least five requiring over 200 acres [Ambuel and Temple, 1982]. The average size of southern Wisconsin woodlot is now about 47 acres. Consequently, many of these area-sensitive, interior-dependent songbird species are decreasing and undergoing population declines.

Change in structure in southern forests caused by over-grazing, logging, cutting and gathering firewood can also impact bird populations. Insect and foliage feeders that rely on the understory in forests for their sustenance may be deprived of a food source. Nesting sites for cavity-nesting birds may also be removed through logging and fire-wood gathering [DNR, 1995].

Amphibians and reptiles, as in the northern forests, have not been thoroughly studied. Denning snakes, like the endangered massasauga rattlesnake, are threatened by encroachment on hibernating sites (hibernaculums) and fragmented and altered habitat. Many amphibians are reliant on vernal ponds for breeding habitat and are very sensitive to changes in forest structure.

Although work has been done on invertebrates of non-forested communities in southern Wisconsin, there is little information about the diversity of these species in the Southern Broadleaf Forest region of the state.